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THE MOONS OF MARS, AND THE NEBULAR HYPOTHESIS.

BY PLINY EARLE CHASE, LL. D.

IN the January number of the ANALYST, Professor Kirkwood says: "Since, therefore, the satellite could never have existed at its present distance in a nebular state, it must follow, if any form of the nebular hypothesis is to be accepted, that its original distance was much greater than the present."

Similar statements have often been made by others, and, as they indicate an apparent misconception of some of the activities of elastic media, it may be well to inquire whether they are strictly correct.

Sir John Herschel states his father's hypothesis as follows. "Admitting the existence of such a medium, dispersed in some cases irregularly through vast regions in space, in others confined to narrower and more definite limits, Sir William Herschel was led to speculate on its gradual subsidence and condensation by the effect of its own gravity, into more or less regular spherical or spheroidal forms, denser (as they must in that case be) towards the centre. Assuming that in the progress of this subsidence, local centres of condensation, subordinate to the general tendency, would not be wanting, he conceived that in this way solid nuclei might arise, whose local gravitation still further condensing, and so absorbing the nebulous matter, each in its immediate neighborhood, might ultimately become stars, and the whole nebulæ finally take on the state of a cluster of stars. . . . Even though we should feel ourselves compelled to reject the idea of a gaseous or vaporous 'nebulous matter', it looses little or none of its force. Subsidence, and the central aggregation consequent on subsidence, may go on quite as well am'g a multitude of discrete bodies under the influence of mutual attraction, and feeble or partially opposing projectile motions, as among the particles of a gaseous fluid." (Outlines of Astronomy, Sect. 871.)

Soon after his discovery, Prof. Asaph Hall sent me the query: "Will the inner moon of Mars fall into harmony or will it make a discord?"

I believe that the tendency of inertia, in all elastic media, to form harmonic nodes, is so great that the evidence of such nodes must be discoverable, wherever we look, both in cosmical and in molecular phenomena. As a necessary consequence of such subsidence as Herschel supposed, there must be an acceleration of velocity in all the nebular particles, the acceleration being more rapid in the nucleus than near the outer surface of the nebula.

Many indications point to the simultaneous, or nearly simultaneous initiation of numerous planetary centres, and it is very doubtful if either of the two-planet belts, except, perhaps that of Neptune and Uranus, will be long regarded as having been "thrown off" by the mere increase of centrifugal velocity. But if the separation is owing to the velocity acquired by subsidence, a satellite may have any velocity which can be maintained by stable harmonic action.

One of the simplest sources of harmony is the division of a linear pendulum into three equal parts, and the synchronism of vibration, whether the suspension is made at the extremity, or at either of the dividing points. In the case of Mars, if we start from a point near the theoretical beginning of nebular condensation for the outer satellite (see Phil. Mag. for Oct. 1877, page 292), and take a series of harmonic divisors of the form $d_{n+1} = 3d_n - d_1$, we find the following accordances:

Divisors.	Quotients.	Observed.
13.7 $d_1 = 1$	13.700	13.692 = Nebular radius.
$d_2 = 3d_1 - d_1 = 2$	6.850	6.846 = Deimus.
$d_3 = 3d_2 - d_1 = 5$	2.740	2.730 = Phobus.
$d_4 = 3d_3 - d_1 = 14$	.979	1.000 = Semidiameter.
$d_5 = 3d_4 - d_1 = 41$	.334	.333 = Centre of radial occil'n,
$d_6 = 3d_5 - d_1 = 122$		120.560 = Moon's major axis.
$d_7 = 3d_6 - d_1 = 365$		365.256 = Terrestrial year.

The reason for the accordance of the terrestrial and lunar harmonies with those of the Martial system, may be understood by considering that the Earth is midway between the secular perihelion of Mercury and the secular aphelion of Mars, and is, therefore, the centre of the belt of greatest condensation in the solar system.

NOTE ON PROF. A. HALL'S QUERY IN VOL. VII, NO. 4, BY PROF. H. T. EDDY.—The eight values which $\nabla^2 v$ assumes at the surface of an attracting body, when v is the potential due to the attraction of the body are explained in sufficient detail in Mr. Todhunter's History of the Theory of Attraction and Figure of the Earth. In chapter XXXI, which he devotes entirely to the consideration of this function of v, he discusses the erroneous result $-2\pi\rho$ obtained by Poisson, as well as the erroneous results obtained by Ostragradsky at singular points of the surface.

I object to the statement made by Mr. Stone in answer to this query in Vol. VII, No. 5, where he states that these eight values are obtained on the supposition that the second differential coefficients of v with respect to x, y, z are independent. The word *independent* does not correctly convey